TREES FOR PEOPLE

an account of the forestry research program
supported by the
International Development Research Centre

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Trees for People

an account of the forestry research program supported by the International Development Research Centre

Clyde Sanger

with the collaboration of

Gilles Lessard and Gunnar Poulsen

Les forêts précèdent les peuples;
Les déserts les suivent.

Voltaire

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Preparing seedlings in a nursery in Jordan.

Foreword

The International Development Research Centre recently published a booklet entitled "The Agriculture, Food and Nutrition Sciences Division: The First Five Years." The publication provides a macroscopic account of the philosophy and priorities that have guided the Agriculture, Food and Nutrition Sciences (AFNS) staff in the Division's program. It describes briefly the projects that make up the programs in crops and cropping systems, animal production and health, fisheries, forestry, and post-production systems. The Centre now intends to produce a series of publications describing what has been attempted and achieved in each component of the AFNS program. This publication is the first of the series and is concerned with forestry.

Though many agencies have supported large afforestation programs in developing countries, there appears to have been less concern for forestry integrated with other forms of land use and in particular with the need for greater production of forest products by and for the use of poor rural communities. As with the AFNS crop science program, highest priority was given to projects in arid and semi-arid lands and a modest but impressive network of projects is being supported in about a dozen countries of Africa and the Near East.

The AFNS program has also encouraged research into the more productive and economical utilization of tropical timbers, particularly those classed as "secondary" forest species. It is believed that many tropical trees, at present ignored or wasted, can be economically used as structural materials or for other purposes of benefit to rural communities.

More recently, encouragement has been given to agroforestry, the integration of tree growing with other aspects of agriculture. The AFNS Division is now acting as executing agency for a new research entity, the International Council for Research in Agroforestry (ICRAF), an organization that will complement the Division's expanding program of support for forestry research in developing countries.

Joseph H. Hulse
Director
Agriculture, Food and Nutrition Sciences Division, IDRC

Trees are useful to man in two distinct ways: as producers of a wide variety of goods, commonly called 'forest produce,' and as custodians of favourable environmental conditions. It would not make sense to try to qualify one of these functions as more important than the other. Both are indisputably essential to the well-being, indeed to the survival, of man.

Gunnar Poulsen

Introduction

Peoples all over the world are coming to a belated realization of the irreplaceable value of trees. Yet for several years the statistics have struck some shocking warnings. H.N. Le Houérou, of the United Nations Food and Agriculture Organization, estimated in 1970 that overgrazing and deforestation in North Africa was resulting in 100 000 hectares of land being lost to the desert *each year* in Morocco, Algeria, Tunisia, and Libya.[1] John Bene endorses the prediction that "within the next 25 to 30 years most of the (world's) humid tropical forest as we now know it will be transformed into unproductive land, and the deterioration of the savanna into desert will continue at ever increasing speed."[2]

He adds: "This should not, and must not, happen." The forestry program of the International Development Research Centre is a contribution to a worldwide effort to prevent this disaster.

The program has been concerned with both functions of trees referred to by Mr. Poulsen, production of wood and fibre and protection of the environment. Often a single research project combines work on both. After all, a shelterbelt on the edges of the Sahara in Africa may provide protection against wind erosion and also produce poles for house building or posts for fencing. An afforestation project in the Andean highlands may improve watershed management and prevent soil erosion on those steep slopes, and at the same time produce sawn wood for industrial purposes. Experiments in agroforestry in the humid tropics — some have begun in West Africa, others will follow in Latin America and Asia — are aimed at improving the environmental conditions on farmland, thereby increasing yields, while providing the small farmer with tree crops.

The majority of the projects described in this booklet, therefore, cover both areas of usefulness. A few, particularly those mentioned in the section on Tropical Timber Utilization, are concerned simply with productive uses. The objective behind a few others is purely protective, but that usually includes protection of farmland for food crop production.

When the IDRC was established in 1970 to support research designed to adapt science and technology to the specific needs of developing

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[1]Le Houérou, H.N. 1970. North Africa: past, present and future. In Dregne, H.E., ed., Arid lands in transition. Washington, American Association for the Advancement of Science.

[2]Bene, J.G., Beall, H.W., and Côté, A. 1977. Trees, Food, and People: land management in the tropics. Ottawa, International Development Research Centre, IDRC-084e.

regions, its Governors set as a first priority the encouragement of research to improve conditions for people living in the arid and semi-arid tropical areas. They did this because they recognized that this belt across the middle of the world was the region where human needs had been most neglected by research workers. The foresty program fitted into this framework. It sought to tackle some of the major problems facing the 150 million people who live in the African savanna. In later years the program spread into Latin America, and it is now likely to move into parts of Asia as a result of a workshop held in Singapore in June 1977 to identify priorities in forestry research in that region.

The Forest Research Working Group that met in Dakar, Senegal, in January 1974 was the first such regional meeting ever to take place in Africa. The eight existing research stations of the Centre Technique Forestière Tropical (CTFT) of France, which extended from Senegal to Madagascar, had links back to Paris, but their experiences and findings were not communicated to the nonfrancophone countries of Africa. In fact, relatively little exchange of research results was effected within the francophone countries. Equally, the forestry research work supported by the Food and Agriculture Organization during the 1960s in Nigeria, Sudan, and Tunisia did not involve contacts with other West African countries.

So the Savanna Working Group, comprising forest research scientists from six countries (Tunisia, Mali, Ghana, Nigeria, the Sudan, and Senegal), was breaking new ground. Its members came from differing ecological subregions and operated inside varying political structures. Some of their governments paid more attention than others to the problems and potential of forestry activity. To work out a collaborative program of research among a group with diverse backgrounds could have been a difficult task.

Gilles Lessard, IDRC Associate Director for forestry, took the three-day meeting at Dakar through the same pattern of discussion as was followed three years later with the group in Singapore. They spent the first day learning about one another's situation. Each country representative (he was either director of a forestry institute or of the government's forestry service) was asked in turn to say where forestry fitted into the national development plan, whether there was a national strategy for forestry development, and whether his research program was fashioned to fit this strategy. Each of them also explained what staff and facilities he had, what were his highest priorities in forestry research, and what work had already been done. Detailed explanations were not requested. The idea was to paint a broad panorama.

At the same time, they learned about IDRC's mode of operation. They learned that it was not a technical assistance agency, and that any project it supported would be directed by a national of that country. In this way the experience would remain in Africa after the end of the particular project, rather than vanish with some foreign "expert." They were also told that IDRC was concerned about the applicability of any research results — would more than one country, or a small region, be able to benefit from the work? Finally, Mr Lessard asked the group to

assess their priority projects on the basis of three criteria: financial rate of return, effect on the quality of the environment, and job creation.

By the afternoon of the third day, members of the group had produced recommendations for research based on these assessments. They came down heavily in favour of research involving the establishment of shelterbelts, irrigated plantations, and projects of soil restoration. They also wanted to see a bureau set up in the area as a documentation and coordination centre for forestry research.

As a practical first step toward such a centre, IDRC in 1976 appointed Gunnar Poulsen, a forester from Denmark who has worked for many years in Africa, including 10 years in the Sudan, to be head of a small cooperative group that will from its Nairobi base travel round a network of forestry research projects and institutions in an advisory role, and will organize the writing of manuals and the running of training courses. This cooperative research effort is described more fully in a later section.

From the Dakar meeting have come a dozen proposals for research projects in savanna foresty that are now in progress. A short description of each is given in the sections that follow. While the section on Forest Plantation Research might have been subdivided between (1) irrigated and (2) rainfed, as is the practice in more technical publications, it was thought more convenient for the general reader to subdivide according to the main end use — shelter, fuel, or fodder — rather than the means.

There were two different origins to IDRC's involvement in agroforestry research. H.R. Grinnell, of Canada's Department of the Environment, was seconded to IDRC and based for nine months at the International Institute for Tropical Agriculture (IITA) at Ibadan, to make a study of the potential in West Africa for agrisilviculture, a system of alternating planting of agricultural crops and forest fallow practiced in the humid tropics. In the process of writing his report for IDRC in 1975 he organized two workshops, and the four projects in agrisilviculture described below are one result of those meetings.

In parallel, a team under John Bene (senior adviser to the President of IDRC) began in July 1975 a Project for Identification of Tropical Forestry Research Priorities. The team focused its attention in particular upon agroforestry, which is defined as a sustainable management system that combines trees with agricultural crops and/or animals. The team's report, entitled Trees, Food, and People — land management in the tropics, has led to the establishment of the International Council for Research in Agroforestry (ICRAF). The recommendations in this report, both concerning ICRAF and research priorities in the natural forest and the man-made forest, are summarized later.

It should be said here that IDRC support in the semi-arid areas has been concentrated on research in the man-made forest, rather than in the natural forest. This is because intensive plantation forestry may best serve the urgent needs for fuel, fibre, and food of the growing populations. The natural forests in semi-arid areas have survived their enemies — fire and browsing animals — only by developing a hardiness that paid its price in productivity: the surviving trees are slow-growing

and produce an annual average of 0.5 cubic metres of wood per hectare of forest land. In contrast, by introducing some fast-growing exotic species for intensive cultivation, and by carrying out species and provenance trials, one can hope to grow at least 50 times more wood in the same surface area — up to 30 cubic metres per hectare a year — albeit at a price, artificial plantations being more exposed to pests and diseases.

To put it in the mathematics of fuel needs: each person in towns in the semi-arid areas verging on the Sahara needs one cubic metre of stacked firewood a year for cooking and heating purposes. It takes two hectares of natural forest to supply one townperson's needs and, as cities grow, that means a wider and wider search for fuel. It is estimated that by 1990 people will be hauling firewood into Ougadougou from a radius of 150 km around the Upper Volta capital. But a single hectare of Australian *Eucalyptus* in a plantation irrigated from a river can supply the needs of 50 people. Drought-resistant legumes such as *Acacia* and *Prosopis*, supply the needs of 25 people in rainfed conditions where there is less than 500 mm of rainfall a year. With such an imbalance of yields between the natural and man-made forests, the research priorities establish themselves.

A further question is whether this research should be aimed at establishing plantations as a state or a village-type operation. Clearly there is no hard-and-fast answer for all circumstances, but ideally the greater the participation of the local people, the better. The younger trees need the same protection as food crops; just as a farmer protects his millet by shepherding his goat, so a village should be able to protect trees it values by other means than expensive fencing. The very establishment of plantations is enormously costly if carried out by forestry employees, and the "taungya" system of allowing a tenant farmer some temporary land to grow food crops in return for his reforestation work ensures his involvement in protection of the young trees together with his crops.

Large areas have been planted through other forms of local participation. In Ethiopia, after villagers had given only a lukewarm reception to government exhortations to plant trees, they began to discover the profits to be made in growing firewood for Addis Ababa and numerous other towns as well as smaller communities; within a relatively short period about 100 000 hectares of *Eucalyptus* were established through local initiative.

Cousinly examples also help. When people in Niger learned how their Hausa relatives south of the border in Nigeria were planting woodlots, their enthusiasm was aroused to do the same.

Whatever system of operation is decided upon, and whatever the motivation of the local people, the IDRC's ability to offer "untied aid" gives it an advantage over some other agencies. It has the means to support the work of local staff, rather than just expatriates, and it can help in the popularizing of research results. This important second task is still at a preparatory stage. The following sections of the booklet amount to a preliminary report on what is still a young program.

Forest Plantation Research

Shelterbelts

Farmers have been planting shelterbelts to protect their fields (and windbreaks to protect their houses and orchards) for many centuries. But it only in the last 40 or 50 years that scientific principles, including aerodynamics, have been applied to the subject. In the 1930s the farmers of the great plains of the United States and the Soviet Union faced similar problems of soil drifting from the deserts and loss of moisture by excessive evaporation. They tackled these problems on a massive scale. Some 1.6 million hectares of shelterbelt were planted between the Ukraine and the river Ural, to protect against soil drifting westward from beyond the river. The Americans planted 29 000 km of shelterbelts in seven years, and the benefits were remarkable: wheat yields in the Dakotas rose by as much as 50 percent. A little later, the Chinese undertook large-scale planting of shelterbelts, as did the Indians in the Rajasthan desert.

Africa's need is as great in shelterbelt establishment, but progress there was until recently confined to areas north of the Sahara. The French introduced them to the Maghreb countries on a modest basis, and planting on some scale also took place in Egypt.

It was soon discovered that, to fit local conditions, a variety of types of shelterbelts needed to be tried. The American and Soviet foresters usually managed with only one to three lines of trees protecting fields from winds that came from one prevailing direction. But the barrier needs to be thicker in cases where fine sand is blowing from the desert and, in the lowland areas of a country like Yemen where the direction of harmful winds varies widely, a chessboard pattern may be necessary, rather than one straight line. If the fields are irrigated, the trees should take up as little space (and water) as possible, unless a supply of forest produce also needs to be satisfied.

Both in cases where shelterbelts are established to reduce the velocity of desiccating winds and where the main purpose is to intercept airborne soil particles, aerodynamics must be considered. Although 90 percent of the moving soil never rises more than 30 cm above ground level, bouncing onto and off the ground, a low solid barrier will not be effective. Erection of a relatively solid barrier may in fact result in turbulence in front of the shelterbelt, a fast air current passing over the barrier will dive down into the relative vacuum that has been created. Most experts in the field of shelterbelt research favour shelterbelts that break the force of a wind by the dual process of absorption and upward deflection. There needs to be a uniform density of branches for, if a line of

A shelterbelt of Casuarina, now 12 years old and planted in a grid pattern, protects farmland from desert southwest of Alexandria.

Eucalyptus with bushy crowns but few lower branches stands alone, winds may be deflected downward. So there is a tendency to streamline a shelterbelt on the windward side with shorter bushes on the outside. This may also allow the taller trees on the leeward side to grow taller. Some experts maintain, however, that shelterbelts should be streamlined as little as possible, in order to disturb the air and reduce the wind velocity. Height is certainly important, all agree; the protected area to leeward benefiting from some degree of protection is usually calculated as 20 times the height of the shelterbelt, and a smaller area is protected in front of the shelterbelt.

There are several other considerations that will prompt shelterbelt planners to make different choices, but enough has been said to explain the need for research to be supported in various circumstances. Of the following projects, the work in northern Sudan is on irrigated land, to reclaim an area near the Nile for year-round production of vegetables, cereals, as well as fruit trees. In northern Nigeria the work is on rain-fed land, to identify suitable species — neem (*Azadirachta indica*) has so far shown the best results — and improve silvicultural practices. Whereas the primary concern has been to reduce the winds from the north and "stop the desert before it eats Nigeria," it may turn out that the most effective answer is not an unbroken belt that cuts across the lines of farms, but a patchwork of clumps of trees strategically placed around farms and helping to extend the growing season, mainly by improving the microclimatic conditions.

Foresters in Tunisia have experimented with shelterbelts for decades and have tried many kinds: some on irrigated land, others on rain-fed; some planted around a perimeter with secondary lines inside; some shelterbelts of mixed species, combining trees planted for production of timber and/or forage with industrial plantations and forage trees planted mainly for their protective qualities. But no comprehensive assessment of comparative benefits has been made so far. A study of the interaction of wind velocities on both sides of various types of shelterbelts at different times of the year and various crop yields, along with testing other ecological factors may provide information and lessons of great value for many countries on both sides of the Sahara.

The project in Egypt is at this stage more a matter of research into methods of breeding improved species of *Casuarina* from those already established and others to be introduced from Australia. It is therefore listed in a later section. Nevertheless, it deserves mention here as the main use of *Casuarina* in Egypt is as shelterbelts protecting farmlands from desiccating winds and sands blowing from the desert toward the Nile. A study is also under way of the timber properties of the various varieties, in the hope that the *Casuarina* can produce income not only as fuel and poles but also as industrial timber.

Establishment of Shelterbelts for Land Reclamation

IDRC grant: $165 000 recipient contribution: $158 900
5 years from 1975 file: 74-0029

contact: Mr H.A. Musnad
Ministry of Agriculture, Food and Natural Resources
Research and Education Institute
P.O. Box 658, Khartoum, SUDAN

Objectives

To find ways of recovering abandoned agricultural land, and of protecting existing farmland adjacent to the desert by: investigating the best design of shelterbelts to counteract desert creep and hot dry winds; studying the differences in yield and quality of crops grown under sheltered and unsheltered conditions; studying the effects on the microclimate and water economy of shelterbelt protection; and making a preliminary evaluation of the economics of land reclamation and desert farming behind protective tree plantations.

Background and Progress

Farming, which was practiced in large depressions or basins along the river Nile that were filled with rich alluvial soil during the flood season, virtually ceased because the construction of dams along the headwaters of the river since the 1930s progressively cut off the annual flooding. In an attempt to reclaim land for farming, the Sudan government in 1956 arranged for wells to be drilled in these basins. This apparently solved the irrigation problem, but farmers had to abandon these areas again because the crops were damaged by desiccating winds and scarifying sand particles and, after some time, sand blowing in from the desert even buried the fields and obliterated the irrigation farrows. An alternative solution later suggested was the establishment of shelterbelts.

This project covers several hundred hectares in the Kerma basin, 40 km northeast of Dongola in northern Sudan. So far very promising results have been obtained with such species as *Prosopis chilensis*, *Eucalyptus camaldulensis*, and *Gonocarpus lancifolius*.

Influence of Shelterbelts on Agricultural Production

IDRC grant: $274 900 recipient contribution: $426 810
4 years from 1975 file: 73-0114

contact: Mr A. Ogigirigi
Principal Research Officer
Savanna Forestry Research Station
P.M.B. 1039
Samaru, Zaria, NIGERIA

Objectives

To determine the value of shelterbelts, and other types of protective tree plantations, in improving agricultural production and the quality of the environment by: carrying out species trials, including various planting and cultural methods; and studying the economics of establishing shelterbelts, and the effects of shelterbelts on crop yields, water conservation, and the local environment.

Background and Progress

More than 400 hectares of shelterbelts have been established in Nigeria's northernmost states, and a five-year program costing $1 million annually is in progress to plant more lines in areas that are drought affected and swept by the Harmattan wind. Foresters have encountered difficulties in establishing continuous strips of trees on dry land having various soils and planting conditions. Costs per hectare have also been high. *Eucalyptus camaldulensis* and neem have done well in certain circumstances. In this project, land for research work has been obtained, after some delay, and laboratory equipment acquired. The first trial plots have been established with a number of interesting species, but it is too early to start analyzing results.

Effects of Shelterbelts on Agricultural Crops

IDRC grant: $212 900 recipient contribution: $175 400
3 years from 1977 file: 77-0018

contact: Mr M. Charfi
Insitut National de Recherches Forestières (INRF)
Ministère de l'Agriculture
Route de la Soukra B.P.2
Ariana, TUNISIA

Objectives

To investigate the physical and biological effects of shelterbelts on crops, in order to develop belts that provide protection in different seasons by: identifying the windbreaks that have shown themselves best adapted for physical protection of crops; studying their biological effects on the growth and yield of crops in both rainfed and irrigated areas; and investigating their moderating influence on the microclimate at times of extreme temperature.

Background

A survey in 1966 by both INRF and l'Institut National de la Recherche Agronomique de la Tunisie (INRAT) revealed that many shelterbelts were ill planned to protect crops against the most harmful winds, including the hot Sirocco. They were sometimes too dense, sometimes too close to the crops and occupying too much space; also some species were chosen more for their lower cost of establishment than for their effectiveness in reducing wind or producing wood. Other questions at issue have been the amount of water they take from, or conserve for, the crops, and the amount of mulch various species of *Acacia* and *Eucalyptus* provide. Now staff of INRF and INRAT will be quantifying the effects of various shelterbelts established mainly since 1969, collaborating with three other Mediterranean countries (Algeria, France, and Turkey) that are doing comparable studies.

Fuel Plantations

The most important use made of trees in Africa is as fuel, either firewood or charcoal. Mr Poulsen estimates that 90 percent of the wood taken from natural forests and plantations is consumed as fuel, 6 percent as poles and posts, 3 percent as sawn wood.

The shortages that are threatening Africa were well documented by Erik Eckholm in his Worldwatch publication The Other Energy Crisis: Firewood (1975). In this booklet the example has already been given of the townspeople of Ougadougou, the capital of Upper Volta but hardly a metropolis, having by the year 1990 to draw their firewood from as far away as 150 km. Further to the east in Niger, some 700 000 people live in the Zinder district and it is estimated that at least 100 000 rain-fed hectares will have to be afforested in this region during the next few years if their fuel and pole needs are to be supplied; already millet straw and animal manure, which formerly served to fertilize the fields, are being used to fire pottery in the Zinder region because of the shortage of wood. The experiements there with village woodlots are an attempt to provide fuelwood of suitable species close to home, and to enlist community support in maintaining the woodlots and protecting the trees — particularly the vulnerable neem — from goats.

In the Ségou district of Mali, near Niono, irrigated agriculture was introduced in the inner delta area of the Niger River along the flood irrigation principles used in the Sudan near Khartoum. But the conditions for irrigated forest plantations are different from the Sudan: the soil is

Growing Eucalyptus as fuelwood on marginal land northwest of Kisumu, Kenya.

more permeable and the groundwater table is influenced by irrigation in nearby ricefields during the growing season. So considerable research was needed to find the most suitable species, and to improve irrigation control and soil preparation. *Eucalyptus camaldulensis* has grown well at N'doubougou and can serve as shelterbelts to protect vegetable crops as well as provide fuelwood and timber.

Competition between forestry and agriculture is at present strong in Kenya, as land-hungry farm families cut into the natural forest and the man-made plantations that were established during colonial years in the high rainfall highland areas on both sides of the Rift Valley. Since 1960 more than 150 000 hectares in these areas have been converted to agricultural crops. To reduce this competition — in effect, to yield these forest areas to agriculture without drastically reducing the national total of forest land — research has begun on species of *Eucalyptus* and *Callitris* as well as other genera that will grow well on marginal lands and help supply the country's increasing needs for building poles, posts, firewood, and charcoal.

In Jordan a national reforestation program has been launched to establish forests, both for wood production and soil protection, in the higher rainfall areas. The degradation of land, which was once covered by vast forests before yielding to the inroads of shifting agriculture and the appetites of livestock, can (it is thought) be reversed. Further south, along the Aqaba road, where the annual rainfall is no more than 80 mm and occurs in two or three storms, experiments have begun in techniques of run-off collection that could sustain drought-resistant forest trees and hardy fruit trees such as pomegranates, figs, and apricots. Generations ago the bedouins practiced run-off collection with earth dikes, and these skills need to be relearned.

The two projects being supported in the Andean highlands of Peru and Bolivia have a similar background. In Peru most of the natural forest species have been heavily cut for fuel and construction wood over the centuries because a majority of the country's population has been concentrated in the high plateau valleys of the Sierra. Both there and in the Bolivian highlands the mining industry has created large demands for charcoal for smelting purposes and timber for pitprops. Daily temperature variations in the Bolivian altiplano of as much as 15 °C are normal; this causes not only a high demand for fuelwood for heating but also makes the establishment of forests difficult.

Establishment of Village Woodlots

IDRC grant: $141 200 recipient contribution: $113 000
5 years from 1974 file: 72-0093

contact: Mr Ibrahim Najada
Directeur du Service des Eaux et Forêts
Ministère de l'Economie Rurale
B.P. 578, Niamey, NIGER

Objectives

To produce firewood and posts and poles in village woodlots to satisfy the needs of the rural population by: conducting species trials, mainly of trees exotic to the Zinder region, to study their growth and behaviour in the arid Sahelian zone.

Background and Progress

The shortage of firewood in the Sahelian zone has become acute because heavy overexploitation of the natural forest has been compounded by years of drought, impeding natural regeneration, and a population growth that has put heavy pressures on the remaining resources. In some areas villagers have had regularly to walk 25 km or more to cover their daily needs for domestic fuel. This project aims to establish some 160 hectares of woodlots near 70 villages in the Zinder region. Plantations have been successfully established in the districts of Matameye and Magaria, but of the wide range of species tried so far, only neem (*Azadirachta indica*) has proved well adapted to the environmental conditions. Neem also has the important advantage for woodlots of coppicing well after exploitation. However, a less expensive form of protection against goats than the present use of wire netting is needed if the project is to prove successful.

Species and Yield Trials for Irrigated Forest Plantations

IDRC grant: $190 000 recipient contribution: $139 650
5 years from 1974 file: 73-0115

contact: M. Jean Djigui Keita
Directeur, Service des Eaux et Forêts
Ministère du Développement Rural
Bamako, MALI

Objectives

To satisfy the timber and fuel needs of rural populations in the Soudano-Sahelian zone of Mali through the establishment of irrigated forest plantations by: selecting the most appropriate species and studying their behaviour under irrigation; developing silvicultural techniques (including site preparation and water requirements) for irrigated tree crops; and determining the potential economic benefits of such plantations.

Background and Progress

The research is being conducted on 66 hectares of land belonging to the Niger River Authority near Niono where extensive agricultural irrigation schemes have created a need for forest plantations both for production purposes and as windbreaks. Initial investigations, involving a considerable number of species, point to *Eucalyptus camaldulensis* as by far the most promising. *Casuarina sp.* and *Dalbergia sissoo* also seem well adapted, but show less vigorous growth. Research is now being aimed at identifying a wider range of species and provenances, particularly from the *Eucalyptus* genus, and at refining irrigation methods.

Afforestation of Arid Lands

IDRC grant: $168 200 — recipient contribution: $75 000
3 years from 1976 — file: 75-0120

contact: Dr Abdul Rahman Talli
Director-General, Forests and Soil Conservation
Ministry of Agriculture
P.O. Box 2179, Amman, JORDAN

Objectives

To undertake silvicultural studies to improve afforestation methods on severely eroded and biologically degraded land; to evaluate tree-growing potential on selected sites in the arid zone, using rainfall runoff collection plots; and to train local officers in experimental methods for forest research.

Background and Progress

The Jordan Government has set a target of establishing 9000 hectares of forest in arid zones by 1980. So far the most successful species planted, for example on terraced limestone hills northeast of Amman, is *Pinus halepensis*, although *Eucalyptus camaldulensis* has also been successfully established along valleys. A training centre is being built at Kemaldiya with combined IDRC and German assistance. The run-off plantation trials are taking place at five sites along the Aqaba road, about 200 km south of Amman.

Afforestation of Marginal Lands

IDRC grant: $190 900 recipient contribution: $125 500
4 years from 1975 file: 74-0020

contact: Dr J.A. Odera
Conservator of Forests (Research)
Ministry of Natural Resources
P.O. Box 74, Kikuyu, KENYA

Objectives

To develop expertise in afforestation of dry and marginal lands not suitable for agriculture; specifically, to investigate tree species that will grow on dry and marginal lands, to study the most practical silvicultural techniques for these sites, and to undertake preliminary economic analysis of the most promising species for the production of various forest products.

Background and Progress

A scheme to interest farmers in forestry on marginal land was initiated by the Kenya Government in 1970, but did not meet its objectives because of a lack of research data and experience in tree planting in such areas. Softwoods such as pine and cypress, which have been grown for many years on the good farmlands of the highlands, did not thrive in the poorer soils, and the lower rainfall areas that cover most of Kenya. Sites at Ramogi, near the Kavirondo Gulf in western Kenya, and at Hola near the Tana river in eastern Kenya were chosen for this project to give experience in growing forests in bushland, bush grassland, and wooded grassland. Species trials under way at Ramogi indicate that *Eucalyptus camaldulenis*, *E. maculata*, and *Callitris hugelii* are best adapted for growth in these rocky and low rainfall conditions.

Species Trials for the Production of Fuelwood on the Bolivian Altiplano

IDRC grant: $175 400 recipient contribution: $73 300
3 years from 1976 file: 76-0126

contact: Colonel Alfredo Calvi B.
Director, Centro de Desarrollo Forestal
La Paz, BOLIVIA

Objectives

To make possible the establishment of forest plantations by rural communities on the Bolivian altiplano in order to meet the domestic and industrial needs of the region; specifically, to select fast-growing species for the production of fuel wood and charcoal at high elevations, and to investigate establishment techniques on different sites that will be suitable for small-scale plantations managed by farmers.

Background

The Bolivian highlands, or altiplano, covers one-quarter of the country's area and is the home of more than half of Bolivia's 6 million rural population, who obtain only low returns from crops on its impoverished soil. The state mining enterprise requires more than 50 000 tonnes of wood charcoal a year, and there are growing demands for timber from a nearby source for the mining industry. Thus, prospects are good for improvement of the highland people's livelihood if forests can be established at altitudes between 3000 and 4000 metres. Species trials are starting near Challapata in Oruro department, and also south of La Paz, and are concentrating mainly on 11 varieties each of pine and *Eucalyptus*.

Species Trials and Plantation Methods for the Andean Highlands

IDRC grant: $295 900 recipient contribution: $112 500
3 years from 1976 file: 76-0090

contact: Dr Marc Dourojeanni Ricordi
Director General, Forestal y de Fauna
Ministeria de Agricultura
Lima, PERU

Objectives

To find suitable species and develop adequate methods for the establishment of forest plantations in the Andean highlands that will be beneficial to the rural population and the economy; specifically, to select suitable tree species, to investigate various nursery and plantation techniques with a view to reducing establishment costs, and to initiate studies of the technical feasibility of integrating plantation forestry with pastoral farming.

Background

The Peruvian Government's priorities in forestry include establishing large scale plantations in the Sierra (highlands) for purposes of protecting the watershed and producing timber for the mining industry and chemical pulp for the paper industry toward the coast. It has chosen the heavily populated and economically depressed zones of Huaraz, Huancayo, and Cuzco in central and southern Peru as areas in each of which to establish 100 000 hectares of forest. This project involves species trials of some 50 varieties of *Eucalyptus* and pine at sites in these three zones. The study to investigate the feasibility of integrating plantation forestry with pastoral farming is limited to two species, *Pinus radiata* and *E. globulus*, which are already adapted to highland conditions. They are being planted at the project sites with wide interrow spacing to provide open plantations for grazing.

Forage Trees

The use of trees as cattle feed is extremely important in the arid zones of Africa, where livestock obtain much of their nourishment in the form of pods and leaves from trees. In a vivid phrase that emphasizes this function, they have been called "aerial pastures." In places like northern Senegal, where herds have multiplied, they have devastated the ground pasturage for large areas around wells and other water sources; here the importance of trees both for forage and for plant cover is increased. Unfortunately, the trees themselves have been abused, being stripped of their branches by cattlemen in search of fodder for their flocks and herds.

The research near M'Bidi, close to the Senegal River, has concentrated on various species of *Acacia* because, although other trees have been planted, *Acacia* alone has shown a high enough survival rate and a vigorous enough growth to be of economic interest as plantations on rangeland. Of the indigenous species, *A. nilotica* and *A. senegal* have grown well, but some species from Australia, *A. holosericea* and *A. victoriae*, for example, may give the best results. An obstacle to be overcome is the high cost of establishing such plantations.

Leucaena, a tree of the mimosa group with its origins in Central America, has spread widely because of its remarkable range of uses. In the Philippines, where its commonest species is called "ipil-ipil," it has been grown for its uses as firewood and charcoal, and also for terracing steep slopes and as shade trees above other crops. In terms of forage, its leaves and seeds are harvested as feed for cattle, poultry, and rabbits. It also has fertilizing value, enhanced by its ability to fix atmospheric nitrogen. But research is needed to reduce its mimosine content, which can have toxic effects on animals. Other limiting factors — its slow seedling growth, the nutrient deficiencies it encounters in acid or waterlogged soils — require investigation to discover its full potential and its limitations.

Herds around water sources in northern Senegal take toll of pasture and trees alike.

Reforestation of Rangeland with Fodder Trees

IDRC grant: $173 800 recipient contribution: $258 240
4 years from 1974 file: 74-0003

contact: Mr el Hadji Sène
Directeur, Direction des Eaux et Forêts et Chasses,
Ministère du Développement Rural
B.P. 1831
Dakar, SENEGAL

Objectives

To improve the quality of the environment in the Sahelian zone and the living conditions of peasants and herdsmen by facilitating their settlement near waterpoints; specifically, to select forest species (whether indigenous or exotic) that are drought resistant and provide good forage, to develop silvicultural methods in nurseries and plantations for these species, and to establish a model pastoral area with integrated management of open space and vegetation around a water source.

Background and Progress

Over the past 20 years, grazing intensity on the rangelands in the sub-Sahara region by the seminomadic tribes has increased steadily because of the boring of deep wells to establish waterpoints for livestock, and also because the animal population has grown as a result of moves to eradicate diseases. However, the heavy traffic of as many as 20 000 head of cattle, sheep, and goats passing a waterpoint during one period of transhumance has turned many such areas into near-desert. The Government of Senegal hopes to reforest the surroundings of 75 waterpoints in the north of the country, based on the experience from this project on a 200-hectare site near the well at M'Bidi. The species trials have shown high survival rates and vigorous growth with four indigenous varieties of *Acacia* that may provide wood products as well as cattle feed and also improve microclimatic conditions.

Potential of Leucaena as a Forage and Tree Crop

IDRC grant: $250 000 recipient contribution: $300 000
3 years from 1977 file: 76-0015

contact: Dr Filiberto Pollisco
Director, Forest Research Institute
Department of Natural Resources
College, Laguna, 3720
PHILIPPINES

Objectives

To study the nutrient requirements of *Leucaena* in relation to various soil types and end-uses; to investigate the uptake and return of nutrients by *Leucaena* in intercropping farming systems involving food or forage crops; to determine the scientific and economic aspects of using *Leucaena* as animal feed on small farms; to screen rhizobial cultures and develop the most efficient techniques of seed treatment for optimum nodulation and rapid establishment of *Leucaena* seedling; and to assemble a wider range of *Leucaena* strains to evaluate their characteristics for the production of feeds and wood products under Philippines conditions.

Background

The most common of 51 reported species of the genus is *Leucaena leucocephala*, of which some forms of this multipurpose leguminous tree can mature in six years, reaching a height of 18 metres and a diameter of 25 cm. The economic potential of these giant *Leucaenas*, as sources of organic fertilizer, feed, and fuel has attracted much interest since selection and improvement work in Australia and Hawaii led to the release of some new varieties for commercial use. In Hawaii it has been shown that one hectare of *Leucaena* interplanted with guinea grass can support at least three head of cattle. The research to be carried out in the Philippines (where the common types of *Leucaena* are already abundant) is aimed both at overcoming various limiting factors to its cultivation as a forage crop (slow seedling growth, poor performance on acid and certain other soils, high mimosine content) and at investigating claims made for it, for example that it returns exceptional amounts of mineral nutrients to the soil in green manuring.

Agroforestry Research

Shifting cultivation, or slash-and-burn agriculture, is still widely practiced in many parts of the world. It is estimated that 250 million people live by it, and 3600 million hectares are at present under this farming system. The system works well when periods of bush fallow, of 6 years or longer, allow for replenishment of soil nutrients.

However, increasing population pressure on the land has made it difficult to operate the system. The heavy demands upon the land for cultivation do not leave it long enough in bush fallow, and the soil becomes severely depleted during the periods of intensive cultivation. A downward spiral develops. In eastern Nigeria, for example, arable crop yields in the fields furthest from the homestead have dropped sharply as the fallow period is reduced below five years and trees and plants are given no time to help regenerate the soil. In contrast, the fields closer to the compound maintain their fertility, supplied by household refuse and manure and mulching material from the homestead's trees, which also provide food, firewood, and building materials for humans, shade and forage for the animals.

The four research projects described in this section constitute an attempt to find ways, through improved forestry practices, to halt this land degeneration. By providing farm families with additional non-agricultural employment and income, pressure on the land may be reduced and thus the fallow period stabilized at a minimum of seven years.

The work in Ghana is concentrating on identifying the best species to grow for fuelwood and poles on fallow land, the most appropriate spacing of trees, and the most productive sequence of alternating agriculture and tree crops. One site is a tobacco-growing area at Wenchi, north of Kumasi, the other is in forest reserves and on communal lands further south, which may produce poles for transmission lines and wood for match factories.

In Nigeria the research under the auspices of the Farming Systems Program of IITA is focused more on improving methods of producing annual staple food crops within the taungya system of reafforestation in Cross River state. Meanwhile in Oyo state, foresters are mainly studying the effects on soil fertility of man-made plantations that have been established on degraded farmland, in order to advise smallholders about conditions for profitable agrisilviculture.

Finally, in Cameroon, a team of agronomists and foresters will be concentrating on leguminous species of trees, both indigenous and exotic, that have a capacity for nitrogen fixation. They will identify which of these species are most effective in restoring fertility to the soil. The

Slash and burn methods often allow too little time for regeneration.

network of four projects will be strengthened by various exchange visits — for example, two Cameroon students will take a Master's degree at Ibadan — and more immediately by visits to all the sites from the cooperative group whose work will be described in the next section.

Introduction of Agrisilviculture Systems on Private Land

IDRC grant: $280 000 recipient contribution: $105 150
3 years from 1976 file: 76-0008

contact: Mr Addo-Ashong
Director
Forest Products Research Institute
University P.O. Box 63
Kumasi, GHANA

Objectives

To increase food and wood production through the introduction of an agrisilvicultural system that will improve small farmers' income while increasing the productivity of the land, specifically: to study on various sites in the humid tropical zone the effects of a planted tree fallow on soil fertility, as compared with the traditional method of shifting cultivation with bush fallow; to determine the relative economic effects of alternative agrisilviculture to farmers through the establishment of an operational agrisilvicultural land use system; and to train professional and technical personnel in agrisilvicultural research techniques and practices.

Background

As a result of large-scale cultivation of tobacco, cotton, and maize, the forests in the Wenchi area of the transition zone (altitude between 300 and 500 metres) between the high forest and savanna woodlands are disappearing faster than they are replenished by natural regeneration during a bush fallow of 5 to 8 years. A number of chiefs and individual farmers, concerned with the consequences of forest destruction, asked to participate in agrisilviculture experiments on their private and communal lands. There is strong demand for forest products, especially fuelwood for tobacco curing. Research in the Oda high forest district is taking place in Esen Epan Forest Reserve and adjacent communal lands, and it is thought that *Triplochiton scleroxylon* and *Funtumea elastica* and some other indigenous species will find a good market in match factories in Accra and Kade.

Effect of Forest Species on Land Productivity in Agrisilviculture Systems

IDRC grant: $271 400 recipient contribution: $167 600
3 years from 1977 file: 76-0007

contact: Dr S.K. Adeyoju
Department of Forest Resources Management
Faculty of Agriculture and Forestry
University of Ibadan
Ibadan, NIGERIA

Objectives

To develop farming systems combining forest trees and food crops in the upland areas of the humid tropics, to the advantage of smallholders and the national economy, specifically: to study the physical limitations and social constraints to the introduction of forest trees in traditional farming systems in western Nigeria; to investigate the different effects of man-made forest plantations and natural bush fallow on land productivity; and to provide postgraduate training for specialists in agrisilviculture systems for the humid tropics.

Background

The Forestry Department of Oyo state in western Nigeria is planning to make seedlings available to small farmers interested in growing forest trees on land that would normally revert to bush fallow after one or two years of cropping. To offer a pilot project of this sort a fair hope of success, the University of Ibadan team is surveying farming communities near Ijaiye forest reserve to identify suitable farmers on the basis of their past experience with food crops and farming systems, combined with the availability of capital, labour, and markets. The team will also study plantations established near Ibadan and Ore within the past 20 years to analyze the effects of various species on soil fertility. Effects on agricultural yields will be estimated from comparative trials with maize, yams, and vegetables planted in plots where *Tectona grandis*, *Cassia siamea*, and *Gmelina arborea* have been grown and in plots established on adjacent bush fallow.

Food Crop Production in Traditional Agrisilviculture Systems

IDRC grant: $95 200 recipient contribution: staff plus facilities
3 years from 1977 file: 76-0130

contact: Dr B.N. Okigbo
Assistant Director
Farming Systems Program
International Institute for Tropical Agriculture
P.M.B. 5320
Ibadan, NIGERIA

Objectives

To study the role of indigenous tree species in traditional farming systems and alternative systems of arable crop production in taungya systems of reafforestation; specifically, within the taungya system, to quantify the productivity of alternative systems of food crop production under different stages of maturity of the forest, different densities of forest canopy, and selected management practices; and, in a survey of traditional farming systems, to assess the contribution of tree species to soil fertility and of their products to the farmers' livelihood; and, through combining the above studies, to recommend for testing improved cropping systems within a taungya system, as well as areas of biological research and forms of technology that may increase the long-term agricultural productivity of the taungya system, and suggest under what circumstances agrisilviculture systems, using quick maturing trees, may be attractive to the small farmer.

Background

The Cross River state government in the lowland humid tropics of southeastern Nigeria has been developing forests for several years using a taungya system of clearing natural forest and reafforesting. Under this system a forester's concern has been for long-term timber production, without exploring possibilities for intercropping annual food staples during the early stages of establishing the forest. In the same region small farmers have cleared forest areas for short-term food production. They, like the foresters in the taungya system, may in the clearing process destroy sources of timber and plants useful for several purposes, including restoring soil fertility. The research is concerned with finding ways to use all the available natural resources for increased food production.

Selection of Leguminous Trees for Agrisilviculture Systems

IDRC grant: $220 500 recipient contribution: $75 200
3 years from 1977 file: 76-0040

contact: M. A.M. Maimo
Directeur
Centre de Recherches Forestières
Institut de Recherches Agrinomiques et Forestières (IRAF)
B.P. 832, Douala, CAMEROUN

Objectives

To improve peasant farming systems in the humid tropics by making full use of leguminous trees to increase agricultural and tree production, specifically: to study the farming systems and the use made in rural areas of forest products from the dense humid forest zone of Littoral province; and to select promising leguminous species and establish experimental plantations in order to study their effect in restoring soil fertility in areas impoverished by shifting agriculture.

Background

It is widely believed that leguminous trees can restore organic matter and mineral elements to impoverished soils more rapidly than any other species. In any case most trees belonging to this group possess the ability to fix atmospheric nitrogen. Despite this and other advantages they possess, they do not appear to hold an important place in farming systems in the humid tropics. Forestry research in Cameroon has until now focused on leguminous species only for use as timber and for pulp and paper products. The IRAF team in this research project is concerned with exploring their possible agronomic role, and will experiment with various fast-growing indigenous and exotic species in forest areas near the town of Edéa, where the average rainfall is 2600 mm a year and the mean temperature is above 26 °C, ecologically typical of the dense humid forest zones of West Africa.

Network Cooperation in Africa

When the directors of several forestry research institutes met in Dakar in January 1974 to identify their most urgent research needs, and to plan cooperation between forestry staff in their own countries and others facing similar problems in Africa, the participants mentioned a number of matters involving coordination. These included the exchange of research results, the organization of technical meetings and field visits, practical training for research staff, and the exchange of plant materials.

In January 1976 a second workshop, attended by representatives of forest research departments from eight African countries, reviewed with some satisfaction the individual research projects that had been launched in the interval. They emphasized the wish to direct and manage their own research activities. At the same time, they expressed the need for some technical guidance, and for access to practical information that was relevant to specific and common problems.

The long-term solution, they believed, was some permanent mechanism — a clearinghouse at the least, and probably a full-blown international centre — to provide these services. In the meantime, they agreed on a pilot project that would test the effectiveness of such a network across Africa. As a result, IDRC offered to support for four years the work of a three-member team based in Nairobi but traveling widely to provide on-the-spot advice. In late 1976 Mr Gunnar Poulsen was appointed Principal Adviser and team leader; two African advisers were to be hired later.

As the basis for the network they will serve, the 15 IDRC-supported projects described in this booklet were a logical selection. But the network is far from exclusive. Other projects will be added, as they are approved by the Centre's Board of Governors. The team is to organize training courses for scientists from these and other related projects. It will also assemble working groups from research institutes in several countries to discuss their experience in various programs: shelterbelts were planned as the topic of the first such meeting.

A good deal of knowledge on forestry research in Africa has not been gathered, and much of it may vanish with the French, British, Belgian, Spanish, and Portuguese colonial staff working on it. So the cooperative project has funds to hire three part-time consultants to assemble this knowledge and prepare state-of-the-art publications on several topics of concern to project staff. In line with the IDRC precept that work should be directed by nationals of the region, these manuals will be critically reviewed, before publication, by editorial groups drawn from the forestry research workers of the region. Then, with necessary changes, they will be published in English and French for the guidance of

From Sudan to Senegal Acacia is grown for gum arabic production; experiments at M'Bidi attract visitors from several countries.

research workers and the use of students in forestry schools. Training in practical research skills is seen as an urgent need for many African forestry institutes, and these manuals will (it is hoped) play a full part here.

It is also important to stimulate closer cooperation between French- and English-speaking research workers. This can be partially achieved by sharing information through manuals. A more vivid impact may be made through field visits, such as the one made to Mali in February 1977 by Hassan Musnad, head of the Sudan's arid zone forestry research, and the return visit paid by Malians to Sudan.

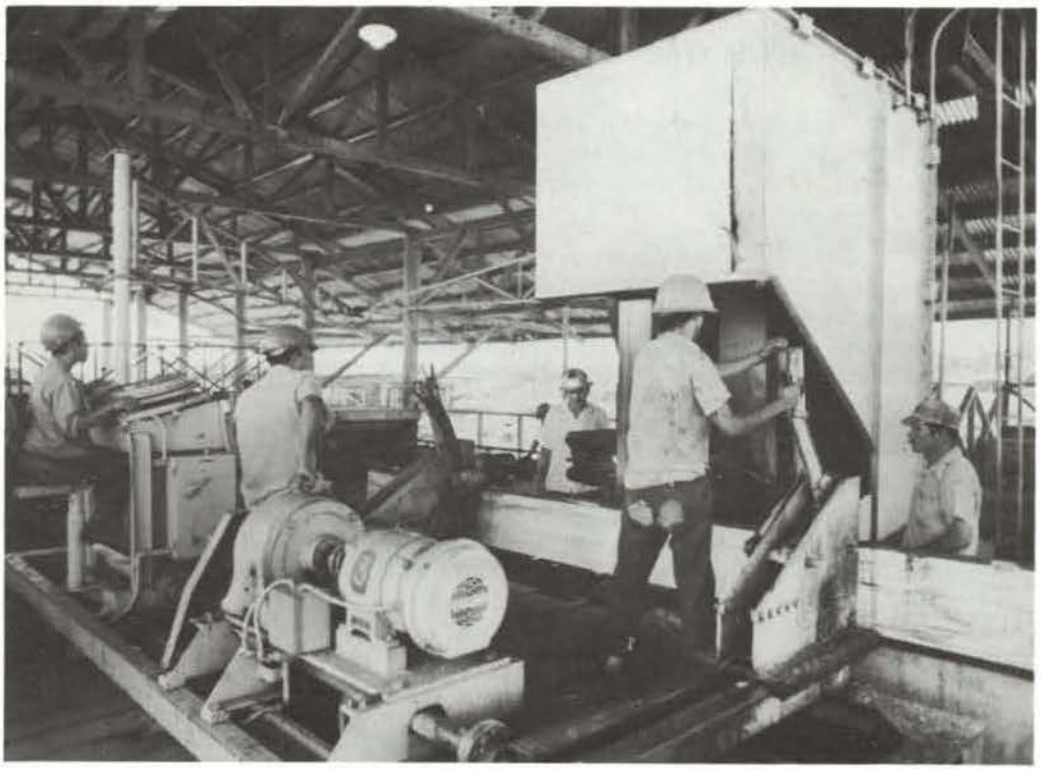
This is a novel approach to applied forestry research: a team of traveling advisers, not resident directors, who try in all spheres to link together fact-finding, review, and training activities. Their work in turn will be reviewed and evaluated by an Advisory Group of seven senior African forestry officers, meeting at least once a year. The first meeting will be held in September 1977 in Nairobi, just after the U.N. Conference on Desertification.

Tropical Timber Utilization

For centuries in the humid tropics the forests have been attacked by loggers who, in search of a few highly valued trees for export, have damaged or destroyed much of the surrounding area. The result of this creaming of the best stems of the favoured species, leaving only inferior trees to reproduce, has been a progressive decline in the quality of the forests.

Five countries of the Andean Pact (Venezuela, Colombia, Ecuador, Peru, and Bolivia) are a special case. Tree growth dominates on more than 220 million hectares (or 60 percent) of their land area. Of the 650 species known botanically in this subregion, about 400 have potential commercial value. Yet it is estimated that only about one-thousandth of this total resource is effectively used. At present only about 50 species are used commercially and usually no more than six species are harvested in any particular location, even though the rain forests are heterogeneous and have a low volume of any one species in a given area. To complete the anomaly, there is an unsatisfied demand for industrial timber, particularly for housing and furniture.

Testing timber for its industrial properties at a sawmill in Iparia, Peru.



The projects listed below grew out of an earlier IDRC-supported study of a regional strategy for the scientific and technological development of these Andean Pact countries. The target was set of investigating 100 timber species that are available in large enough quantities for industrial use, and determining their functional properties — for woodworking and machining, for drying and preservation, for jointing and so forth — in the construction industry. The concern is to use the available timber not only effectively, but also for national and regional purposes — not, as in previous times, as a luxury export. Further, by opening up new possibilities for the saw-milling and lumber industries of the region, it can help considerably in job creation.

Two, less ambitious, projects have been supported in West Africa. Mali has several million hectares of natural forest in its savanna regions, but these have not been at all developed, being far from the coast and the international trade that stimulated research into the physical properties of trees of the humid tropics. As a result, Mali has been importing at high cost timber for such basic articles as canoes, fish crates, and doorframes. In the first phase of the project, a study was made of the physical and mechanical properties of the most important savanna timbers; in the second phase a survey will follow of the country's needs and the extent to which imported wood is being used in each sector.

In Ghana the objective has been to develop an inexpensive form of "wood-wool" building slab from timber and mineral binder materials (cement, magnesite, or gypsum) that are locally available, and test these panels for resistance to fire, insects, and decay. The manufacturing process for wood-cement blocks, relying on uncomplicated technology and labour-intensive methods, may be viable in many countries where the market for such products is still limited.

Development of Technology for the Use of Tropical Timber in Construction

IDRC grant: $1 051 620 recipient contribution: $735 350
2.5 years from 1975 file: 74-0009

contact: Mr Luis Soto Krebs
Junta del Acuerdo de Cartagena
Casilla 3237
Lima, PERU

Objectives

To determine the industrial properties of at least 100 timber species, and develop technology for the use of tropical woods for structural purposes in construction. In six related subprojects: (1) to determine the physical and mechanical properties of selected species for various forms of industrial use, and standardize test methods for evaluating wood properties; (2) to develop standards for the visual grading of tropical sawn woods according to defect, and to establish structural values for specific grades of timber; (3) to design and test wood building elements, and prepare design tables and charts for a wide range of structures; (4) to develop efficient systems of jointing and uniting members of tropical wood species for use in timber framing construction; (5) to develop suitable drying and preservation methods for different conditions of use; and (6) to determine the woodworking and machining properties of tropical woods, particularly with regard to their finishing characteristics.

Progress

The background to this project has been sketched in the introduction to this section on utilization, so that a note on progress should suffice here. The project has been carried out by a technical group at the headquarters of the Junta (the Andean Pact secretariat) and by research institutions in the five countries (Venezuela, Colombia, Ecuador, Peru, and Bolivia). It started somewhat behind schedule, partly because of difficulties over the patent agreement, but then progressed satisfactorily. The published results of the project will consist of two manuals, some 30 technical norms dealing with timber construction and five technical reports containing results of the subprojects.

Manufacture of Wood-Cement Building Boards

IDRC grant: $67 250 — recipient contribution: $29 330
2.5 years from 1973 — file: 72-0091

contact: Mr W.K. Anokye
Forest Products Research Institute
University P.O. Box 63
Kumasi, GHANA

Objectives

To develop the technology for producing, by labour-intensive systems, mineral bound organic particle boards from forestry materials and other by-products indigenous to the tropics of Africa; to test the physical and chemical properties of the particle boards produced, and their resistance to climatic and biological hazards; and to determine the cost of production of the formulations and systems considered technically most efficient.

Progress

The project moved slowly at first, because of the closure in 1974 of the Pioneer Woodwool Factory in Takoradi, which was to have supplied slabs for the demonstration buildings and to have helped test various forest species. Only in mid-1975, when a "Sella" wood-wool machine arrived from Italy, could work get fully under way. Then, with a concrete mixer and moulds, a small-scale production unit was set up at Kumasi. Utile (*Entandrophragma utile*) and Musanga (*Musanga cecropioides*) have been found to be two of the more suitable species for production. Tests were done to find the best mixture of calcium chloride and seawater to act as the mineralizing agent. Later however, a much cheaper and locally available addition, pozzalana, was found to provide the desired results. Pozzalana is a residue from bauxite mining. Portland cement, manufactured in Ghana, was used as the principal binding agent. Tests of the physical properties of the board have been carried out on a special machine adapted from a timber testing machine. A problem of shrinkage was encountered after the panels had dried for some weeks. Thermal and acoustics tests were carried out in early 1977, and other tests of resistance to termites and fungi were scheduled for later in the year.

Technological Properties and Utilization of Savanna Timber Species

IDRC grants: $269 500
6 years from 1972

recipient contributions: $181 750
files: 72-0094, 74-0165

contact: M. Jean Djigui Keita
Directeur, Service des Eaux et Forêts
Ministère du Développement Rural
Bamako, MALI

Objectives

To acquire greater knowledge of the savanna timber species in order to make effective use of them in satisfying the local needs in forest products; specifically in the first three-year phase to: study the technological properties of several little known savanna species; develop simple techniques for their processing; and train a scientific staff in wood technology. In the second three-year phase to: carry out a statistical survey of the principal and other uses of commercial timber (imported and indigenous) as it is presently used; develop sawing, drying, and processing techniques for local woods; and suggest improvements in the use of the principal savanna forest species.

Progress

Research during the first phase was carried out at l'Institut Polytechnique Rurale at Katibougou, near Bamako, where special buildings have been erected and laboratory equipment installed. At first, wood samples were sent abroad for testing. Some delays have been encountered in installing the pilot sawing and machine facilities. However, with the return of one research worker from a course at a wood laboratory in France and of two MSc graduates in wood technology from Laval University in Canada, a competent scientific staff has been built up for the second phase. Comprehensive laboratory tests showed that the most promising savanna species belong to the following seven genera: *Isoberlinia, Daniella, Pterocarpus, Bombax, Terminalia, Anogeissus*, and *Diospyrus*. During Phase 2 the staff will concentrate on studies of the practical use of these species.

Other Promising Research Areas

Although the previous sections give a description of the present main areas of IDRC concern in forestry research, they are not exclusive. If a project proposal has come to the Centre that was thought worthy of support but fell outside these areas, it was still approved. The following collection of five projects gives some proof of this statement.

The first two projects fall into the category of improvement of tree species. *Casuarina* (briefly mentioned in the Shelterbelts section) came to Egypt from its Australian source only in three or four of the 45 known species. *C. glauca* is the commonest in Egypt followed by *C. cunninghamiana;* however, *C. equisetifolia* has been preferred by some farmers near Alexandria because it does not compete with agricultural crops for soil nitrogen because it fixes atmospheric nitrogen in root nodules. It is more than possible, however, that species yet to be introduced from Australia will prove even better as fast-growing trees that have good characteristics for the wood-using industry after serving their time as shelterbelts.

The improvement of two *Acacia* species — *A. senegal* and *A. laeta* — was undertaken at M'Bidi in northern Senegal, in order to raise the quality and quantity of the gum arabic that these species exude. Senegal is second only to the Sudan as an exporter of gum arabic to industrialized countries for use as a water-soluble gum in various foods and drinks and in the pharmaceutical industry. The seminomadic herdsmen of this area stand to gain an important secondary income if the productivity, quantitatively and qualitatively of the gum trees is improved.

Alfa grass or esparto (*Stipa tenacissima*) grows widely through the semi-arid areas of North Africa. It covers more than 7 million hectares in Algeria and 1.5 million in Tunisia. It has been used for more than a century in paper making, for which it has several qualities, including smoothness, opaqueness, resilience, and freedom from humidity. A mill in Kasserine, in central Tunisia, produces 70 000 tonnes of pulp and paper a year from alfa grass and 20 000 rural families find seasonal work harvesting the crop, which they do by a technique of twirling the grass round a stick and pulling by hand to break it at a joint. Yet surprisingly little is known about its biological aspects: what are the best conditions for growth; whether it is damanged (although not eaten, for its sharp edges protect it) by livestock in pasture; or whether its growth will stop if it is harvested by a simple cutting machine instead of backbreaking labour.

The two other projects grouped in this miscellaneous section concern a test on a large-scale photographic survey system for tropical forests, which was carried out in Surinam in 1973, and a study being planned of the threat of pine bark beetles to forests in Central America.

Breeding and Improving of Casuarina for Shelterbelt Plantations in Egypt

IDRC grant: $134 400
3 years from 1976

recipient contribution: $37 600
file: 75-0048

contact: Dr O.A. Badran
Department of Forestry
Faculty of Agriculture
Alexandria University
EGYPT

Objectives

To select the best genetic material from *Casuarina* stands already existing in Egypt, and identify promising species and provenances abroad; to develop tree-breeding methods; to improve the silvicultural practices used for shelterbelt establishment; and to study the timber properties of the different varieties with a view to using the wood in converted form as well as for fuel and poles.

Progress

Since there has been virtually no research work done elsewhere in the breeding and improvement of *Casuarina,* the most fundamental aspects were investigated first. Morphological studies to identify the species grown in Egypt revealed three distinct species: *C. glauca, C. cunninghamiana* and *C. equisetifolia.* A hybrid of the first two species was identified for the first time. Serology and chemotaxonomy were also used to study relationships of the species.

Several plus trees were marked and mapped in different regions of Egypt during 1976, and germination tests were carried out on seed samples from "plus" trees and from mass collections. Field trials were done of the growth and survival rates of seedlings of the various species. A study of vegetative propagation, including cutting and grafting, was encouraging and a clonal seed orchard is being established during 1977. A lengthy study-tour of Australia in mid-1977 by Dr Hosny opened the way for introduction trials of some new varieties. Considerable research on timber properties has also taken place in the university laboratories.

Selection of Acacia for the Production of Gum Arabic

IDRC grant: $202 600 recipient contribution: $109 620
4 years from 1973 file: 72-0096

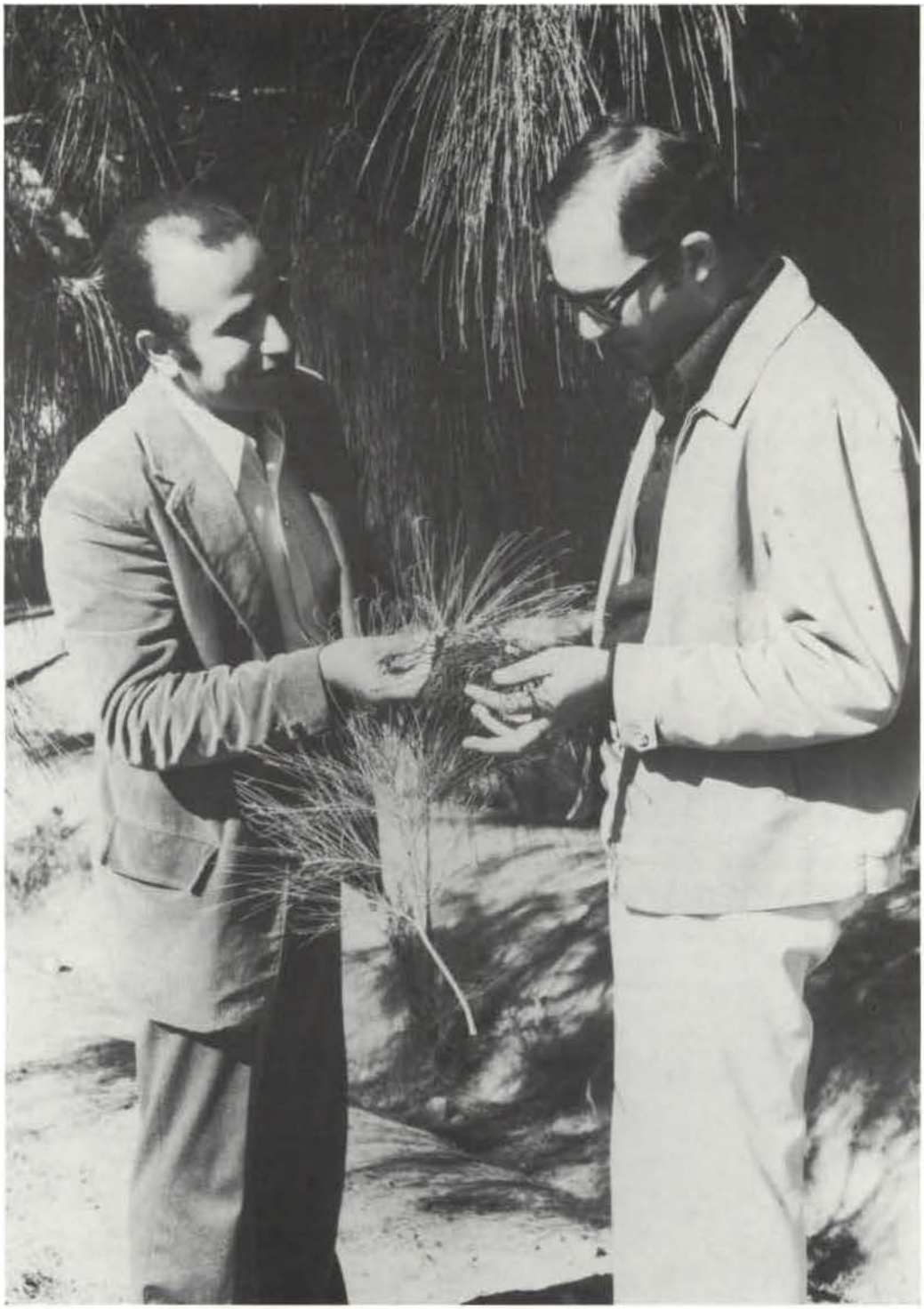
contact: M. E.H. Sène
Service des Eaux, Forêts et Chasses,
Parc Forestier de Hann, Boite Postale 1831,
Dakar, SENEGAL

Objectives

To improve the production methods and the quality of gum arabic; specifically, to carry out experiments in genetic improvement, and agronomic trials with *Acacia senegalensis* and *A. laeta*.

Progress

A number of varieties of *A. senegalensis* and *A. laeta* from West African countries (including Niger, Chad, Upper Volta, and Mali besides Senegal) and from the Sudan have been raised successfully on 74 plantation sites at M'Bidi. A high survival rate, of over 90 percent, and vigorous initial growth were obtained by preparing the planting lines with a ripper and by weeding intensively during the first two years. The oldest plantations, established in 1974, are expected to begin yielding gum in 1978. It will then become possible to determine the productivity and other qualities of the various provenances. Research has also been carried out to develop methods for the vegetative reproduction of the gum *Acacias*. Initial results have been favourable, and it should be possible soon to reproduce particularly productive gene-types and to establish seed-orchards on the basis of such selected material.



Checking Casuarina cones during morphological studies in Egypt.

Improvement of the Production and Harvesting Methods of Alfa Grass

IDRC grant: $204 800 recipient contribution: $144 700
3 years from 1975 file: 74-0049

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Objectives

To study means of increasing alfa grass production and improve the methods of its exploitation in the best interests of the local population, specifically: to study the biology of alfa grass, particularly the factors governing its growth; to experiment with methods of cultivation that may improve both its yield and its conservation; and to develop simple machines that would allow the harvesting operation to be mechanized.

Progress

Because so little was known about the plant, despite a century of cultivation in Mediterranean countries, there has been strong emphasis on studying its biology during the first part of the project. Experimental plots have been established in southern Tunisia, to observe its growth when it is not subject either to burning or to pasturage. Tests with simple machinery, such as used in Belgium for harvesting flax, have also been scheduled.

Testing of Radar Altimetre for Aerial Surveys of Tropical Forests

IDRC grant: $15 000
one year from 1972

other agencies: $23 900
file: 72-0099

contact: Mr L. Sayn-Wittgenstein
Forest Management Institute
Canadian Forestry Service
Department of the Environment
Ottawa, CANADA

Objectives

To carry out trials in Surinam of a radar altimetre specially developed for tropical conditions, together with a barometric correction unit; and to test the feasibility of using a large-scale (about 1:1000) and low altitude aerial photographic survey system for tropical forest inventories in place of expensive ground level work.

Progress

Canada's National Research Council improved a standard altimetre to the point where it was thought it could penetrate forest foliage and measure an aircraft's altitude unaffected by intervening vegetation. The barometric correction unit enables the altimetre to produce also a profile of the ground surface below the forest, and is useful in such engineering applications as planning the location of roads. With data from these units, precise measurements from aerial photographs can be made of individual trees — their diameter, height, and volume — as well as an assessment of any damage done.

The Canadian Forestry Service, which had collaborated with the Food and Agriculture Organization in 1968 in a preliminary test of this method in Guatemala, organized some 15 hours of test flights in a Beech 18 aircraft over Surinam in February 1973. The Surinam Department of Development provided support with tree cutters and field labour, as well as darkroom facilities. Results of the experiment in identification of tree species, using colour and colour infrared photography, were excellent. Less satisfactory were the tests on the radar altimetre, which did not completely penetrate the forest canopy and measure the aircraft-to-ground distance. As a consequence, results obtained below 600 m altitude contained too large an error for inventory, and refinements were then recommended. A full report, Measurement of Tropical Trees on Large-Scale Aerial Photographs by A.H. Aldred, was published by Environment Canada in 1976.

Study of Pine Beetle Threat to Tropical Forests

IDRC grant: $31 900 recipient contribution: $8 000 plus facilities
16 months from 1977 file: 77-0008

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Objectives

To study the distribution of the pine bark beetle species present in the forested areas of Guatemala; to analyze their population dynamics as affected by seasonal changes; to quantify the resistance of different conifers to attack by various species; and to recommend control measures.

Background

The pine forests, an important natural resource in Central America, have been widely attacked by pine bark beetles. During the 1960s some 10 billion board feet of timber were destroyed in Honduras through degradation by *Dendroctonus frontalis*; whereas, in the northwestern highlands of Guatemala 140 square kilometres of pine forest have been destroyed or seriously damaged, and most other lumber producing areas of the countries are affected. Beetle populations apparently increase during drier years, and sawmills are thought to be a focus of infestation. But too little is yet known about the beetle's life cycle and patterns of attack to plan control measures. This study, mainly by biology students from the university, may lead to recommendations to develop methods of biological or chemical control.

International Council for Research in Agroforestry (ICRAF)

While research into tropical forestry has been stepped up since the late 1960s, there is still no consensus on priority objectives and the worldwide effort has remained uncoordinated, with many important gaps and wasteful duplications. The IDRC took an initiative in July 1975 to help remedy this situation by setting up a Project for Identification of Research Priorities in Tropical Forestry under the leadership of John Bene, with Herbert Beall acting as project coordinator. The terms of reference of the project were:

(1) to identify significant gaps in world forestry research and training;

(2) to assess interdependence between forestry and agriculture in the low-income tropical countries and propose research leading to the optimization of land use;

(3) to formulate forestry research programs that promise to yield results of considerable economic and social impact on developing countries;

(4) to recommend institutional arrangements to carry out such research effectively and expeditiously;

(5) to prepare a plan of action for international donor support.

An important part of the work done in the earlier stages consisted of regional studies carried out by consultants who canvassed informed opinion in their areas and made recommendations about forestry research needs. A study by Professor J.D. Ovington of Australia covered Indonesia, Papua New Guinea, Fiji, and Malaysia, while another by Dr Filiberto Pollisco of the Philippines covered other areas of Southeast Asia. Professor L. Roche contributed a study dealing primarily with Africa, and Dr Armando Samper one covering Latin America and the Caribbean. In the process, seminars on research priorities were held in Britain and Colombia. Their reports not only provided important material that helped shape the content of the IDRC team's own report Trees, Food, and People: Land Management in the Tropics (IDRC-084e), but also identified specific research proposals. In particular, the reports on Southeast Asia prepared the way for working out a coordinated program of research at the Singapore workshop in June 1977.

Trees, Food, and People synthesises the background information assembled during the course of the study under the title "The tropical forest — overexploited and underused." This assembly of background information leads the team on to listing 23 problem areas of major importance.

Recommendations are made for new research initiatives in tropical forestry and land use "that could, within a period of 5–10 years, lead to a significant improvement in the conditions of life and prosperity of rural people." Sections on research priorities in the natural forest and the man-made forests underline the constraints in these two areas, and lead to the conclusion that the greatest advances in such a time-span are possible in systems that combine tree crops and agriculture in an efficient management system. The emphasis, therefore, in the report's recommendations is upon agroforestry, which it defines as: "a sustainable management system for land that increases overall production, combines agricultural crops, tree crops, and forest plants and/or animals simultaneously or sequentially, and applies management practices that are compatible with the cultural patterns of the local population."

The report says that "the tremendous possibilities" of such production systems are widely recognized, and research is being planned or is under way "in a number of scattered areas." But it "remains sporadic, widely scattered, and largely uncoordinated."

As a result, the proposal was made to launch an International Council for Research in Agroforestry (ICRAF) as a support unit to help remedy these defects. ICRAF, it was suggested, should be supportive and catalytic. It would not conduct research itself, but could collect, screen, and disseminate hard facts relevant to agroforestry production systems, contract for research in appropriate institutions to fill gaps in existing knowledge, foster field trials and demonstration projects, and support training in agroforestry at all levels. In the process, it would encourage an interdisciplinary approach by foresters, agricultualists, and social scientists to improved land management.

It was proposed that ICRAF be established by charter as an autonomous, international body, that it be governed by a Board of Trustees, and that it be managed by a small staff of experts in the essential disciplines who would employ consultants where required to broaden their field of competence. The overall annual cost was estimated at slightly more than $2 million.

In November 1976 a meeting was held of potential donors and other interested agencies, including representatives from 10 nations and three international agencies. At this meeting the need for such a service was endorsed, and it was accepted that there was no satisfactory alternative to a new international organization to provide this service. A Steering Committee, which was set up to consider in detail the establishment of the proposed Council, decided at a meeting in Amsterdam in April 1977 that the amount of support already shown was sufficiently encouraging to move ahead along the lines set out in the IDRC report. It approved a draft charter, studied budget and staffing requirements and an outline of a work program, and appointed IDRC as Executing Agency to deal with the establishment of ICRAF.

While the permanent headquarters of ICRAF is to be in a developing country (as decided by the Board of Trustees), the Steering Committee accepted the invitation of the Netherlands to begin operations in 1977 with a nucleus staff at the Royal Tropical Institute in Amsterdam until

Agroforestry in semi-arid lands: intercropping cowpeas and neem trees in Zinder district, Niger.

arrangements are completed for moving to the permanent location. In the first year, the work of ICRAF will mainly consist of collecting and disseminating information on successful agroforestry techniques. In December 1976 the IDRC Board of Governors approved an appropriation of $300 000 to be used in support of the planning and preliminary operations of ICRAF.

Future Plans

It would probably be helpful to many readers to end with a brief and tentative indication of the directions in which the IDRC forestry program may move in the next few years.

Participants in the Singapore workshop in June 1977 identified 15 priority areas for forestry research in the region, of which the top five were: the rehabilitation of denuded land; agroforestry; watershed management; fast growing plantations for industrial or fuel uses; and forestry for community development (defined broadly as forestry work done by villagers for their own use).

Going beyond the Southeast Asia region, the future directions of the IDRC program may be summarized as follows:

(1) The need for fuel-wood plantations will undoubtedly increase, and this in turn will require further research. Other areas besides Africa will need support, particularly the smaller but densely populated countries of Central America and the Caribbean.

(2) The cost of establishing plantations is of great concern. Some of the present projects have shown the unacceptably high cost of mechanized planting, and in Sahelian regions, where the rainfall is both meagre and unpredictable, hand-planting of large areas is not practical in the few days when there is good chance of survival. So research is needed on techniques for natural regeneration, possibly with pelletized seeds or by planting species (such as *Prosopis chilensis*) at wide intervals and letting animals who eat the seeds do the subsequent spreading. To reduce costs, it will be necessary to use nature as much as possible.

(3) In the same way that a systems approach to postharvest technology has been suggested to reduce the wastage of agricultural crops,[3] so a great deal of fuel or energy could be saved by simple improvements to basic combustion systems. Often the process of carbonization is inefficient, and charcoal making in many countries can be improved. Charcoal braziers and open wood-stoves are usually wasteful.

(4) The rehabilitation of degraded land in areas of Malaysia and Indonesia where logging has taken place is important because large areas have been taken over by worthless secondary vegetation like *Imperata* grass. Rehabilitation may be achieved either through a strongly competitive plant such as *Leucaena* or through agroforestry. The destruction wrought in humid tropical forests by logging operations is as great an ecological disaster as the more publicized (and photographed) degradation of arid

[3]Spurgeon, D.C. 1976. Hidden Harvest: a systems approach to postharvest technology. Ottawa, International Development Research Centre, IDRC-062e.

lands around the Sahara. The U.N. Conference on Desertification is likely to stimulate more research proposals on the latter problem. We should not ignore the former one, either.

(5) Research into agroforestry is now a high priority in several developing regions. These include parts of Asia where shifting cultivation occurs, parts of Latin America, and highland areas in eastern Africa where (as in Rwanda) small farmers face problems of soil degradation and erosion.

Technical Editor: Michael Graham